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A study on digital watermarking algorithms

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Abstract— In this paper, a survey on various digital watermarking techniques has been done. A watermark system is said to be secure, if the hacker cannot remove the watermark without having full knowledge of embedding algorithm, detector and composition of watermark. From the survey, it has been found that none of the technique performs efficiently in all fields. Therefore the paper ends with the future scope to overcome these issues.

***Keywords*- Digital watermarking, DWT, CZT, SVD.**

I. INTRODUCTION

The advancing world of digital multimedia communication is faces problems linked to security and authenticity of digital data. The information security term is referred to as protecting information or digital data against any attack which can be performed by utilizing different attacking technologies, methods and techniques. Digital watermarking hide the copyright information to the digital data through certain algorithm. It is just a technology that helps protect multimedia contents from illegal copying, manipulation and distribution problems by inserting the ownership information to the digital multimedia content without it been noticed by visual representation. The watermark can be hidden in the digital data either visibly or invisibly. For a strong watermark embedding, a good watermarking technique is needed to be applied. Watermark can be embedded either in spatial or frequency domain. A watermark system is said to be secure, if the hacker cannot remove the watermark without having full knowledge of embedding algorithm, detector and composition of watermark. A watermark should only be accessible by authorized parties. On communication channel watermarked may be corrupted by noise. A proper encoding and decoding techniques should remove random noise occur over a communication channel.

II. WATERMARKING TECHNIQUES

Watermarking techniques can be broadly classified into two categories according to operation domain: Spatial and Transform domain methods. Early image watermarking schemes operated directly in spatial domain. Watermarking algorithms are classified into two domains.

- Spatial domain: This domain gives attention to modifying the pixels of a couple of randomly selected subsets of images. It directly loads the raw data in to the image pixels. Some of its algorithms are LSB, SSM Modulation based technique. Spatial algorithms have low complexity and they are easy to implement.
- Frequency domain: This technique resembles spread spectrum communication embeds the watermark by modification of the magnitude coefficient of the digital content based on the embedding algorithm. The frequency domain watermarking has higher computational cost, it has proven become more robust and imperceptible compared to the spatial domain watermarking.

The following transform domain techniques are mostly used in image watermarking:

A. Discrete Wavelet Transform (DWT): The transforms are derive from on small waves, called wavelet, of varying frequency and limited duration. The wavelet transform decompose the image into three spatial directions, i.e. horizontal, vertical and diagonal. Magnitude of DWT coefficients is larger in the cheapest bands (LL) at each degree of decomposition and is smaller for other bands (HH, LH, and HL).The most prominent information of a sign appears in the reduced amplitudes and less prominent information information appears in the low amplitudes. The major benefits of utilizing the DWT to decompose an picture are because of its multiresolution and excellent localization characteristics which are similar to compared to that of the theoretical models of the human visual system (HVS). The fundamental concept of discrete wavelet transform in image process would be multi-differentiated decompose the image into sub-image of different spatial domain and independent frequencies.DWT is most popular because of its frequency spread, multiresolution ability and the spatial localized nature of its wavelet.

B. Singular Value Decomposition (SVD): Singular value decomposition is just a linear algebra technique used to resolve many mathematical problems. SVD is able to efficiently represent the algebraic properties of an image. SVD techniques can be applied to any kind of images. It's usage in watermarking help to attain better transparency and robustness since slight variations of singular value don't affect the visual perception of the cover image. In SVD transformation, a picture of N*N could be decomposed into three matrices i.e. UVS. Where U and V would be the orthogonal matrices with small singular values, and S is a diagonal matrix with the bigger singular value entries of the image.

C. Chirp Z-Transform (CZT): CZT is definitely an algorithm for assess the z-transform of a signal. Z-domain transfer functions could be factored into polynomials with poles and zeros as its roots, where poles model the peak energy concentration of the frequency spectrum and zeros model the troughs of the frequency spectrum.CZT has the ability of evaluating the z-transform at points both inside and outside the system circle. It also offer the power of detecting the

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fundamental frequency, as it can certainly zoom the analyzed frequency spectrum with a quite high resolution.

D. Arnold Transform: Arnold transform is proposed by V. I. Arnold in the study of ergodic theory, it's also known as catmapping, and then applied to digital image. Arnold scrambling algorithm has got the feature of simplicity and periodicity, therefore it is used widely in the digital watermarking technology. Based to the periodicity of Arnold scrambling, the initial image could be restored after several cycles. Since the periodicity of Arnold scrambling depends on the image size, it's to attend for a long time to displace an image. Generally, the cycle of Arnold transformation isn't directly proportional to the image degree. Currently, Arnold scrambling algorithm is based on square digital image in most literature, and these images are mostly $N \times N$ pixels of the digital image. However, most of the digital images are non-square in the real world, so that we cannot use Arnold scrambling algorithm widely. Arnold scrambling recovery has two ways: one is the application of its periodicity, and the other is the pursuit of its inverse matrix to the inverse transformation.

III. LITERATURE SURVEY

Mary Agoyi et al. (2014) proposed a story watermarking scheme on the basis of the discrete wavelet transform (DWT) in conjuction with the chirp z-transform (CZT) and the singular value decomposition (SVD). Firstly, an picture is decomposed into its frequency sub bands by utilizing 1- level DWT. Then, the high frequency sub band is transformed into z-domain by utilizing CZT. Afterward by SVD, the watermark is including with the singular matrix of the transformed image.

Min Li et al. (2013) proposed a brand new image encryption algorithm that may increase the security of image during transmission more effectively. The standard scrambling algorithm predicated on Arnold transformation only relates to the square area, which is really a big limitation. Focus with this, a multi-region algorithm for image scrambling encryption model is proposed, which splits the non-square image to multiple square regions, and scrambles each region. Cedillo-Hernandez et al. (2013) presented a powerful hybrid watermarking method connect with color image for verification, which presents forcefulness against several distortion. Two different approaches occur in a same watermark have found in that method. In the very first one, the luminance component information has used to setting in the watermark bit sequence in to the magnitude of the center frequencies of the DFT. In the 2nd one, a selected region of 2D histogram poised by blue-difference and red-difference chrominance components is modified based on the watermark bit sequence. Anjum et al. (2012) presented a powerful scheme that helps to increase the robustness of the watermark. When the logo is coded using error correcting codes before being embedded in to the watermarked image the robustness of the watermark is increased. Different codes which are taken under consideration inside their paper are Hamming and cyclic codes. Liu et al. (2012) discussed some characters of CZT about accuracy for monotone frequency signals. The CZT error decreases once the sampling time increases, and fluctuates periodically and diminishingly until reaches the resolution. The error distribution relates to the initial phase of the sampled signal. The spectral answers are approximately symmetrical for 2 orthometric signals. A brand new frequency analyzing method, orthometric average chirp-z transform (OACZT), is presented to analyze the ability fundamental frequency more exactly. Chrysochos et al. (2012) A cross watermarking scheme for verification has presented, which demonstrate forcefulness against various attacks. Because of the different nature of filter and geometrical attacks, two different watermarks are found in that scheme. The initial one you have entrenched in frequency domain coupled with chaotic function ad is on the basis of the correlation method. The 2nd watermark has entrenched in luminosity histrogram of the image. In this manner , this hybrid watermarking scheme combines the forcefulness of chaotic domain against filtering, noise and compression attacks with the forcefulness of histrogram domain against geometrical attacks. Kansal et al. (2012) presented |a cross digital image watermarking centered on Discrete Wavelet Transform (DWT), Discrete Cosine Transform (DCT) and Singular Value Decomposition (SVD) in a wind order. From DWT we select the high band to embed the watermark that services to include extra information, gives more invisibility and forcefulness against some attacks such as for example geometric attack. Wind method has been placed on map DCT coefficients into four quadrants that represent low, mid and high bands. Finally, SVD is placed on each quadrant.

Dejey et al. (2011) Combined discrete wavelet transform-fan beam transform (DWT-FBT) has been explored as a brand new possible domain for colour image watermarking. Both schemes proposed in the combined domain are (i) wavelet fan beam watermarking on luminance and chrominance and (ii) wavelet fan beam watermarking on chrominance alone. After applying of DWT on the host image and after careful choice of the suitable band of wavelet coefficients for applying FBT, watermarking is completed by altering the fan beam transformed coefficients. Foo et al. (2010) a normalization-based robust image watermarking scheme which encompasses singular value decomposition (SVD) and discrete cosine transform (DCT) techniques is proposed. For the proposed scheme, the host image is first normalized to a typical form and divided in non-overlapping image blocks. SVD is placed on each block. By concatenating the very first singular values (SV) of adjacent blocks of the normalized image, a SV block is obtained. DCT is then carried on the SV blocks to create SVD-DCT blocks. Lai et al. (2010) proposed a cross image-watermarking scheme predicated on discrete wavelet transform (DWT) and SVD is proposed inside their paper. Inside their approach, the watermark isn't embedded entirely on the wavelet coefficients but instead than on the weather of singular values of the cover image's DWT sub bands. Experiment results have already been provided to demonstrate that the proposed approach can survive a variety of image-processing attacks.

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IV. COMPARISON TABLE

Table 1 represents the comparison among existing techniques for watermarking.

REFERENCES	AUTHORS	YEAR	TECHNIQUES	FEATURES	LIMITATIONS
[1]	Anjum, S.R., Verm, P	2012	DWT based image watermarking using error correcting codes	increase the robustness of the watermark	The use of watermark scrambling is ignored.
[2]	Bedi,S.S ., Kumar, A., Kapoor, P	2009	SVD based DCT-DWT oriented watermark technique	high robustness against JPEG compression	Arnold ignored the data for scrambling
[3]	Cedillo-Hernández, M., García-Ugalde, F., Nakano-Miyatake,M.Pérez-Meana, H.M	2013	hybrid color image watermarking method based on DFT domain and 2D histogram modification	presents forcefulness against several distortion	The effect of multiple attacks is ignored.
[4]	Chandra Mohan, B., Srinivas Kumar, S.:	2008	singular value decomposition	enhance security	The use of watermark scrambling is ignored.
[5]	Chrysochos, E., Fotopoulos, V., Xenos,M., Skodras	2012	hybrid watermarking scheme	robustness of chaotic domain against filtering	Arnold ignored the data for scrambling
[6]	Dejey, D., Rajesh, R.S.:	2011	Discrete wavelet-fan beam transforms	watermarking is completed by altering the fan beam transformed coefficients	The effect of multiple attacks is ignored.
[7]	Foo, S.W., Dong, Q	2010	SVD and DCT	robust image watermarking scheme	The use of watermark scrambling is ignored.
[8]	Kansal, M., Singh, G., Kranthi, B.V	2012	DWT, DCT and SVD	include extra information, gives more invisibility and forcefulness against some attacks	Arnold ignored the data for scrambling
[9]	Lai, C.,Tsai, C	2010	discrete wavelet transform and singular value decomposition	survive a variety of image-processing attacks	The effect of multiple attacks is ignored.
[10]	Liu, G.,Dong, Z.,Yang, S.,Zhao, X	2012	orthometric average chirp-z transform	analyze the ability fundamental frequency more exactly.	The use of watermark scrambling is ignored.
[11]	Mary Agoyi · Erbu˘g Çelebi · Gholamreza Anbarjafari	2014	CZT, DWT, SVD	Robust and efficient	Arnold ignored the data for scrambling
[12]	Min Li, Ting Liang, Yu-jie He	2013	Arnold Transform	increase the security of image during transmission	The effect of multiple attacks is ignored.
[13]	Rahimi, F., Rabani, F	2010	contourlet domain	imperceptible and robust against several common watermarking attacks	The use of watermark scrambling is ignored.
[14]	Riaz, S., Javed, M.Y., Anjum, M.A.:	2008	spatial and frequency domains	robust against many attack	Arnold ignored the data for scrambling
[15]	Song, C., Sudirman, S., Merabti, M., Llewellyn-Jones, D.T	2014	Arnold Transform	offers analysis of several digital image watermark attacks	The effect of multiple attacks is ignored.

V. CONCLUSION AND FUTURE SCOPE

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In this paper, from the survey it has been concluded that the use of watermark scrambling is ignored in the CZT transform based watermarking. Moreover, those who used Arnold for scrambling the data has ignored the CZT transform. Also the effect of multiple attacks is also ignored in existing research. Therefore to overcome these issues, a new watermarking technique can be proposed on the basis of the DWT in conjuction with the CZT and modified SVD to enhance the results.

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